

ROLE OF MR URETHROGRAM IN THE ASSESSMENT OF POSTERIOR URETHRAL DISTRACTION DEFECTS

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DECLARATION

I solemnly declare that this dissertation **“ROLE OF MR URETHROGRAM IN THE ASSESSMENT OF POSTERIOR URETHRAL DISTRACTION DEFECTS”** was prepared by me in the Department of Urology, Madras Medical College and Government General Hospital, Chennai under the guidance and supervision of Professor & HOD Department of Urology, Madras Medical College and Government General Hospital, Chennai between 2006 and 2009.

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Introduction

Blunt trauma with pelvic fracture results in posterior urethral distraction defects (PUDDs) in 10% of cases. Such injury commonly involves the membranous urethra at the bulbomembranous or at the prostatomembranous junction. PUDDs are complex pathologically, involving displacement and misalignment of the severed urethral ends with intervening and surrounding fibrosis. Detached bony fragments and callus formation add to the pathological complexity. For a successful repair of a PUDD it is necessary to identify the specific anatomy of the distraction defect before undertaking any treatment.

Currently combined ante grade and retrograde urethrography is the corner stone of preoperative assessment, and most investigators consider it the standard imaging study of posterior urethral distraction defects. Nonetheless spurious estimation of a long or a short defect can result from incomplete filling of the posterior urethra. Also urethrography cannot identify the prostate gland and the extent, or even presence of scar tissue.

Magnetic resonance imaging (MRI) has recently been introduced by McAninch^{1, 2} and his group as a non invasive method of assessment of posterior urethral injury. It correctly measures the length of the defect with no problems of spurious estimation and clearly depicts the extent of fibrosis and degree and direction of prostatic displacement. Nevertheless, published data have been surprisingly vacant of any report about the use of MRI in the assessment of posterior urethral injuries since 1993 when the two studies

reported by Dixon et al and Narumi^{1, 2} et al were published. Studies in line with those previous reports are clearly needed to push the limits of the clinical usefulness of MRI in cases of posterior urethral distraction defects.

This dissertation is an attempt to study the diagnostic capability of MR Urethrography, its efficacy in visualization of posterior urethra, and also in assessing prostatic apex displacement, in comparison to conventional antegrade and retrograde urethrography.

Aim and objectives

The aim of this study is to

- 1) To determine the role of MR Urethrogram in the evaluation of post traumatic posterior urethral distraction defect.
- 2) To compare MR Urethrogram and conventional opposing urethrogram with the surgical assessment of these complex injuries.
- 3) To find out which among these two investigations, could be the best determinant of the type of management for these patients?

Review of literature

RUG (retrograde urethrography) popularized by **Cunningham** in 1910, has remained the gold standard imaging study for evaluating Urethral Stricture³ for nearly a century. However some authors have reported that this imaging study is not ideal for posterior urethral distraction defects. For posterior urethra, combining retrograde urethrogram with VCUG is more rewarding.

Syed Mamun Mahmud et al⁴ conducted a study between January 2001 to December 2002 to determine the role of ascending urethrogram in decision making for patients with suspected urethral strictures. The study concluded that Ascending Urethrogram does not completely rule out urethral stricture (Negative Predictive Value 76%). It was also observed that urethral stricture may be non-existent even though suggested in ascending Urethrogram (Positive Predictive Value 89%). The sensitivity of ascending urethrogram for diagnosing urethral stricture was 91% and a low specificity of 72% .

J Eaton, MS, FRCS (Uro) et al in 2005⁵ has published the current status of urethral imaging in BJR journals. They have quoted, male urethra is more prone to disease than the female urethra, notably trauma and stricture formation and MRI is central in the diagnosis and management of urethral pathologies such as urethral fistulae ,stricture and malignancy.

Jeong-ah Ryu, MD and Bohyun Kim, MD et al⁶ concluded in their study “MR Imaging of the Male and Female Urethra” that the anatomic details of both the urethra

and periurethral tissues can be evaluated non invasively with magnetic resonance (MR) imaging and it can be used as an adjunctive tool for evaluation of urethral abnormalities. In patients with congenital anomalies, MR imaging is reserved for cases of intersex anomalies or complex genitourinary anomalies, in which evaluation of internal organs is essential. MR imaging may demonstrate diverticula that are not seen on radiographic contrast-enhanced studies, including VCUG, RUG, or double-balloon catheter study. In cases of inflammation, MR imaging can demonstrate not only inflammatory infiltration around the urethra but also the presence of a periurethral abscess or sinus tract. In cases of trauma, MR imaging is helpful in assessing the presence and extent of anterior or posterior urethral injury and predicting the occurrence of complications. At MR imaging, a fistula can be seen as a direct communicating channel with an adjacent organ.

Y. Osman, T. El-Diasty and colleagues from Mansoura Egypt - Magnetic Resonance Urethrography in Comparison to Retrograde Urethrography in Diagnosis of Male Urethral Strictures: study over a 4 month period in 2004, 20 patients of urethral stricture disease were evaluated with conventional retrograde urethrography (RUG) and multiformat MR Urethrography. The patients were then examined by urethroscopy under anesthesia to be followed by definitive endoscopic or open operative intervention. The radiographic data were compared to endoscopic and operative findings in all patients. They concluded MRU as a promising tool for defining anterior and posterior male urethral stricture as it accurately measures the length of stricture, extent of spongiofibrosis and aids in proper surgical selection.

Deuk Jae Sung, MD, et al⁷ prospectively evaluated Magnetic Resonance (MR) urethrography for the depiction of obliterating urethral stricture. Twelve patients with obliterating urethral stricture were examined preoperatively with T2-weighted, T1-weighted, and contrast material-enhanced T1-weighted MR imaging of a urethra distended with sterile lubricating jelly. Ten of the 12 patients were examined with conventional retrograde urethrography (RUG) combined with voiding cystourethrography (VCUG) prior to MR imaging. Each imaging result was compared with either a surgical specimen or a description of the surgical findings to determine which method allowed accurate estimation of stricture length. MR imaging of the urethra distended with sterile lubricating jelly is an effective tool for evaluating obliterative urethral strictures. MR measurements of stricture length demonstrated significantly lower errors ($P < .05$) and better linear fit to surgical measurement than did conventional RUG combined with VCUG measurements ($r^2 = 0.85$, $P < .001$ and $r^2 = 0.03$, $P > .05$, respectively).

Y Narumi, et al¹ assessed the role of MR imaging in defining the surgical approach and in predicting permanent erectile dysfunction in patients with traumatic posterior urethral injury. 27 patients underwent MR imaging before open urethral reconstruction. MR findings were correlated with surgical findings, surgical approach, and sexual potency at 12-month follow-up. MR imaging correctly revealed the length of the urethral injury (allowing for 0.5-cm discrepancy) in 23 of 27 (85%) patients and

displacement of the prostatic apex in 19 of 21 (90%) patients. MR findings prompted a change in the clinically planned surgical approach from perineal to combined perineal and transpubic in seven (26%) cases. Significant variables affecting permanent impotence were avulsion of the corpus cavernosum, ($P < .001$), separation of the corporeal body ($P < .05$), and superior and /or lateral prostatic displacement ($P < .05$). When MR imaging findings of both cavernous avulsion and superior and/or lateral prostatic displacement were present, the probability of permanent impotence was 95%. In the absence of these findings, the probability of normal potency was 83%. MR imaging can be performed to help select the most effective surgical approach and to assess permanent erectile dysfunction.

Anatomy of male urethra

Male urethra is about 8 inches (17.5 cm) long and opens at the tip of the penis. The urethra is divided into anterior and posterior urethra. The anterior urethra (from distal to proximal) includes the meatus, fossa navicularis, penile or pendulous urethra, and bulbar urethra. The posterior urethra (from distal to proximal) includes the membranous urethra and the prostatic urethra. Except during the passage of the urine or semen, the greater part of the urethral canal is a mere transverse cleft or slit, with its upper and under surfaces in contact; at the external orifice the slit is vertical, in the membranous portion irregular or stellate, and in the prostatic portion somewhat arched.

Posterior urethra-Prostatic part

The prostatic portion, the widest and most dilatable part of the canal, is about 3 cm. long. It runs almost vertically through the prostate from its base to its apex, lying nearer its anterior than its posterior surface; the form of the canal is spindle-shaped, being wider in the middle than at either extremity, and narrowest below, where it joins the membranous portion. A transverse section of the canal as it lies in the prostate is horse-shoe-shaped, with the convexity directed forward. Upon the posterior wall or floor is a narrow longitudinal ridge, the urethral crest (verumontanum), formed by an elevation of the mucous membrane and its subjacent tissue. It is from 15 to 17 mm in length, and about 3 mm in height, and contains muscular and erectile tissue. When distended, it may serve to prevent the passage of the semen backward into the bladder. On either side of the crest is a slightly depressed fossa, the prostatic sinus, the floor of

which is perforated by numerous apertures, the orifices of the prostatic ducts from the lateral lobes of the prostate; the ducts of the middle lobe open behind the crest. At the forepart of the urethral crest, below its summit, is a median elevation, the colliculus seminalis, upon or within the margins of which are the orifices of the prostatic utricle and the slit-like openings of the ejaculatory ducts. The prostatic utricle forms a cul-de-sac about 6 mm long, which runs upward and backward in the substance of the prostate behind the middle lobe. Its walls are composed of fibrous tissue, muscle fibres, and mucous membrane, and numerous small glands open on its inner surface

Posterior urethra-Membranous part

The membranous portion is the shortest, least dilatable, and, with the exception of the external orifice, the narrowest part of the canal. It extends downward and forward, with a slight anterior concavity, between the apex of the prostate and the bulb of the urethra, perforating the urogenital diaphragm about 2.5 cm. below and behind the pubic symphysis. The hinder part of the urethral bulb lies in apposition with the inferior fascia of the urogenital diaphragm, but its upper portion diverges somewhat from this fascia: the anterior wall of the membranous urethra is thus prolonged for a short distance in front of the urogenital diaphragm; it measures about 2 cm. in length, while the posterior wall which is between the two fasciae of the diaphragm is only 1.25 cm. long. The membranous portion of the urethra is completely surrounded by the fibres of the sphincter urethra membranaceae. In front of it the deep dorsal vein of the penis enters

the pelvis between the transverse ligament of the pelvis and the arcuate pubic ligament; on either side near its termination are the bulbourethral glands.

Anterior urethra-Cavernous part

The cavernous portion (penile or spongy portion) is the longest part of the urethra, and is contained in the corpus spongiosum. It is about 15 cm long, and extends from the termination of the membranous portion to the external urethral orifice. Commencing below the inferior fascia of the urogenital diaphragm it passes forward and upward to the front of the symphysis pubis; and then, in the flaccid condition of the penis, it bends downward and forward. It is narrow, and of uniform size in the body of the penis, measuring about 6 mm in diameter; it is dilated behind, within the bulb, and again anteriorly within the glans penis, where it forms the fossa navicularis urethra. The external urethral orifice is the most contracted part of the urethra; it is a vertical slit, about 6 mm long, bounded on either side by two small labia.

Blood supply of urethra

The superficial vascular supply to the penis comes from the external pudendal vessels, which arise from the femoral vessels. The external pudendal vessels give rise to the superficial dorsal penile vessels that run dorsolaterally and ventrolaterally along the penile shaft, providing a rich vascular supply to the dartos fascia and skin. The deep penile structures receive their arterial supply from the common penile artery, which

arises from the internal pudendal artery. The common penile artery gives off several branches that include the bulbourethral, cavernosal, and deep dorsal penile arteries. The corpus spongiosum receives a dual blood supply via anastomoses between dorsal and urethral artery branches in the glans. The scrotum receives its vascular supply via branches from both the external and internal pudendal arteries.

Imaging of urethra

RETROGRADE URETHROGRAM:

Retrograde urethrography¹³ is considered to be the best initial study for urethral and periurethral imaging in men and is indicated in the evaluation of urethral injuries, strictures, and fistulas^{10,11}. Retrograde urethrography is a straight forward, readily available, cost-effective examination. The external meatus is prepared in a standard sterile fashion for the placement of a conventional 16- or 18-F Foley catheter. The catheter, with both the irrigating syringe and inflating (saline solution) syringe attached, should be flushed before use. When the balloon portion of the catheter is seated in the fossa navicularis of the penile urethra, the balloon is inflated with 1.0–1.5 ml of saline solution while the port is held with the free hand to partially inflate the balloon¹¹. Lubrication is not recommended because it may prevent the balloon from remaining in place for optimal occlusion. The patient is placed in a supine 45° oblique position. The penis should be placed laterally over the proximal thigh with moderate traction. The patient should be reassured about the discomfort that is experienced during balloon inflation. Then, 20–30 ml of 60% iodinated contrast material is injected under fluoroscopic guidance so that the anterior urethra is filled. Commonly, spasm of the external urethral sphincter will be encountered, which prevents filling of the deep bulbar, membranous, and prostatic urethras. Slow, gentle pressure is usually needed to overcome this resistance. Spot radiographs are obtained when there is visual confirmation of contrast material flowing into the bladder. If properly administered,

contrast material can be seen to jet through the bladder neck into the bladder. The verumontanum is seen as an ovoid filling defect in the posterior part of the prostatic urethra. The distal end of the verumontanum marks the proximal boundary of the membranous urethra, which is approximately 1 cm long and is that portion of the urethra that passes through the urogenital diaphragm. This is also the region of the external sphincter of the urethra. The distal boundary of the membranous urethra (the bulbomembranous junction) is the cone of the bulbar urethra. The identification of the bulbomembranous junction on a retrograde urethrogram is very important for assessing patients with urethral disease as well as for planning urologic procedures. When the posterior urethra is optimally opacified and the verumontanum visible, the bulbomembranous junction can be identified 1–1.5 cm distal to the inferior margin of the verumontanum. When the posterior urethra is sub optimally opacified, the bulbomembranous junction can be arbitrarily localized where an imaginary line connecting the inferior margins of the obturator foramina intersects the urethra.

The anterior urethra extends from its origin at the end of the membranous urethra to the urethral meatus. It is divided into the bulbar (most proximal) segment and the penile (pendulous) segment. There is usually mild angulation of the urethra where these two segments join at the penoscrotal junction. Contraction or spasm of the constrictor nuda muscle, a deep musculotendinous sling of the bulbocavernosus muscle, may cause anterior or, less frequently, circumferential indentation of the proximal bulbous urethra at retrograde urethrography ¹². This bulbous urethral indentation should not be confused

with urethral stricture. If the membranous urethra can be identified, it will not be confused with a stricture. Narrowing elsewhere in the urethra will be clearly defined as separate from the membranous urethra and, therefore, representative of a pathologic stricture. If the patient is not positioned sufficiently oblique, the bulbous urethra will appear foreshortened and will therefore not be adequately evaluated. Filling of the Cowper ducts should not be misinterpreted as extravasation. Opacification of the prostatic ducts, Cowper ducts, and periurethral Littre's glands is often, but not necessarily, associated with urethral inflammatory and stricture disease. If the integrity of the urethral mucosal lining is disrupted by increased pressure during contrast material injection, intravasation of contrast material with opacification of the corpora and draining veins may occur.

Limitations of RUG:

1. Variations in patient positioning and penile traction during imaging can greatly alter the radiographic appearance of the stenotic areas¹⁴.
2. Forceful injection of contrast may lead to a false diagnosis of urethral stricture due to reflex contraction of the pelvic muscles or anaphylaxis and systemic sepsis due to rupture of mucosal barriers¹⁵.
3. Even with technique standardization, stricture length might be inaccurately estimated¹⁶; no information is obtained regarding spongiofibrosis. Bulbar stricture

length is under estimated by this modality. Posterior stricture length is over estimated by this modality

4. Effective antegrade imaging may not be feasible in cases of posttraumatic urethral distraction defect ¹⁷.
5. It also contributes to 0.6% to 1.6% of all hospital acquired infections.
6. There is risk of contrast related allergic reaction and Radiation Exposure which is of 5-9 msv, equivalent to 2.5 years of background radiation and 230 chest X-rays.

VOIDING CYSTOURETHROGRAM:

Voiding cystourethrography¹⁶ is currently the most commonly used imaging method in the evaluation of the male posterior urethra. Voiding urethrography is usually performed after the bladder is filled with contrast material via a suprapubic catheter. After that the patient voids under fluoroscopic observation and spot radiographs of the bladder and urethra are obtained. During active voiding, the bladder neck opens widely and becomes funnel shaped by means of the internal sphincter mechanism. In male patients, the verumontanum appears elongated and the proximal bulbar urethra has a less conical appearance. However, the membranous urethra remains the narrowest segment between these parts of the urethra, even though it may dilate up to 6 or 7 mm in diameter during voiding. Voiding cystourethrography¹⁶ may not demonstrate certain abnormalities of the male anterior urethra because the normal anterior urethra is not fully distended to the

degree seen at retrograde urethrography.

A retrograde study is the most appropriate way to evaluate the anterior part of the urethra, and a voiding study is the most appropriate way to evaluate the posterior part of the urethra; and "dynamic" urethrography represents a synergy of these two imaging techniques. Usually the pelvic fracture patients presenting with PUDD have a suprapubic catheter. A voiding study is done by filling the bladder with contrast through the SPC tube and if the patient is successful in relaxing to void and the cystogram outlines the posterior urethra, a simultaneous antegrade and retrograde urethrogram (UP AND DOWNOGRAM) nicely outlines the length of the distraction defect.

ENDOSCOPY:

When the proximal urethra is not visualized on a simultaneous cystogram with urethrogram, endoscopy through the suprapubic tract in combination with retrograde urethrography can be used to outline the defect. After the endoscopic appearance of the bladder neck is assessed, the flexible endoscope can be advanced through the bladder neck and into the posterior urethra to the level of the obstruction. The appearance of the bladder neck on contrast studies or on antegrade endoscopy does not accurately predict the ultimate function of the bladder neck after urethral reconstruction (Iselin and Webster, 1999). A simultaneous retrograde urethrogram will then outline the anterior urethra, with the space not visualized representing the distraction defect.

SONOURETHROGRAPHY:

To overcome the shortcomings of RUG, sonourethrography in the evaluation of anterior urethral strictures was first introduced by McAninch in 1988¹⁸. Although it was met initially with a high degree of enthusiasm because of the initial promising results as it provides information not only on the urethral lumen but also on the corpus spongiosum, it has not been widely used because of smaller field of view and the poor compliance of urologists¹⁸. Moreover, the results of urethral ultrasound need to be interpreted by an experienced investigator because excessive pressure must be avoided to prevent urethral compression and faulty positive diagnosis. Recently, it was suggested that RUG and sonourethrography be combined to achieve full assessment for patients with anterior urethral strictures. Sonourethrogram has no role in evaluation of Posterior Urethral Distraction Defects¹⁸.

MR Imaging:

Although evaluation of the male urethra using MRI was suggested more than a decade ago¹, it is not yet routinely included in the armamentarium of urethral investigations. In 2003, Pavlica et al¹⁹, in their review of male urethra imaging, judged MRI to be not widely used for examination of male urethral pathologies because it was somewhat complex and offered little extra information. Magnetic resonance imaging (MRI) has been introduced as a noninvasive method of assessment of urethral stricture. MRI can provide anatomic details about both the urethra and periurethral tissue

with orientation of the lesion in three dimensions MRI has been advocated for staging PUDDs ^{7, 8, 9} and using a body-coil can give useful information. Transaxial, coronal and sagittal views are required, and examining all three planes could be useful for evaluating the post-traumatic anatomy.

Both T1- and T2-weighted imaging are often needed to evaluate the male and female urethra. The urethra can be evaluated in orthogonal planes⁷ (axial, sagittal, and coronal) or imaged obliquely along its course. In male patients, the membranous urethra is best evaluated in the axial plane and the relation between the membranous and bulbous urethra (particularly in cases of trauma) is best evaluated in the coronal or sagittal plane. For imaging of the anterior urethra, the penis should be positioned anteriorly in the supine position and taped to the abdominal wall beneath the surface coil or should be taped to the thigh.

A thin section thickness (3–5 mm) and a small intersection gap (1–2 mm) are desirable for imaging the urethra. The signal-to-noise ratio can be improved by using surface coils or endorectal coils ^{24, 25}. Although endocavitary coils may improve the spatial resolution, the small field of view may limit the area of imaging and the high signal intensity in the near field may degrade image quality. Since evaluation of adjacent organs is often essential for diagnosis of urethral disease, it is preferable using pelvic or torso phased-array coils ^{24, 25}. Use of intravenous contrast media can be beneficial in selected cases, particularly in patients with extensive fibrosis or inflammation. Although

a few studies have found that the normal urethra or urethral lesions can be better demonstrated on contrast-enhanced images than on T2-weighted images, they included only a small number of cases and thus lack statistical analysis.

MR Technique:

The MR technique⁷ includes injection of sterile gel into the urethra, then application of a soft clamp to the penile tip to keep the urethra distended. Injection of sterile gel into the urethra allows easier and more stable distention of the urethra compared with saline, as previously described⁷. Bladder is filled with 200-300 ml saline through SPC. Patient is placed in supine position in the MR console. Penis is strapped to the thigh or abdomen. Then, sagittal high-resolution T2 imaging of the penis and urinary bladder is performed with the following parameters: TR=4000–6000_{msec}, TE=80–120_{msec}, slice thickness=2mm, interslice gap=0mm. The reformatted images at different axial, coronal, and sagittal oblique planes are obtained to delineate the entire length of the urethra, characterize the surrounding soft tissue with depth and density of periurethral fibrosis, and define the distraction defect and the displacement. Processing of the images was done at a separate work station. Using T1 sequences⁷, MRI provide high-contrast resolution with good visualization of the tunica albuginea (hypointense) and spongiosum tissue (hyperintense). Fibrotic alterations of the corpus spongiosum can be seen clearly on T1- and T2-weighted images because hypointense areas easily distinguishable from normal spongy tissue. Contrast medium is injected to evaluate the

degree of activity in inflammatory lesions ^{7,30}.

The following MR Imaging findings are evaluated ^{1,2,7,30}

(a) Length of the urethral distraction, as measured by the distance between the prostatic apex and the bulb of the penis on sagittal MR images;

(b) Displacement of the prostate gland in superior, anteroposterior, and lateral planes;

Superior displacement of the prostate was measured as a distance greater than 1 cm between the prostatic apex and the inferior pubic ramus. Anteroposterior displacement was measured as the distance between the prostatic apex and urethral insertion in the roof of the penile bulb. Lateral displacement was measured as the distance between the prostatic apex and the bulbous urethra on the coronal image.

(c) Penile injuries (avulsion of corpus cavernosum from ischium, separation of corpus cavernosum from corpus spongiosum, corporeal body fracture, disrupted or undisrupted pelvic bone fractures).

(d) The presence of extensive scar tissue, is an important factor in treatment planning and MRI can give us an idea about these factors ^{7, 30}

e) MRI is useful in delineation of fistulous tract²¹. Urethral fistulas may communicate with the perineum, rectum, and seminal vesicles and the skin of the thigh and gluteal

muscles. Recto urethral fistulas are rare and are reported to occur from developmental causes, usually in association with complex anorectal abnormalities. At MR imaging, a fistula can be seen as a direct communicating channel with an adjacent organ. However, direct visualization of the fistula is not always possible and only the secondary signs including focal enhancement with loss of intervening fat planes may be seen. The rate of detection of various fistulas with MR imaging has been reported to be fairly high²¹

f) MRI is also useful in deciding the treatment approach ^{22, 23} in cases of posterior urethral distraction defect. To decide the surgical approach preoperative information regarding the relative position of the bulbar urethra and of the prostatic apex is essential. Preoperative assessment of posterior urethral injury has included performance of rectal examination and combined voiding cystourethrography and retrograde urethrography. Although digital rectal examination should be performed to evaluate the shape, configuration, and consistency of the prostate, the position of the prostate can be extremely difficult to define after major trauma. Furthermore, cystourethrography often results in poor filling of the posterior urethra, which makes it more difficult to evaluate the length of the urethral injury.

The primary indications for selecting the transpubic approach ^{22,23} with pubectomy in reconstruction for prostatomembranous stricture are (a) to improve surgical visualization (pubectomy exposes the anterior prostatic surface for complete visualization of the apical structure); (b) to allow a tension-free, mucosa-to-mucosa

anastomosis between the bulbar urethra and the distal prostatic urethra; and (c) to allow removal of scar tissue, fistulous tract, and cavities . The presence of superior prostatic displacement is an important factor in favour of the transpubic approach because the displacement prevents complete visualization of the apical structure. In the past, this condition has been detected at rectal examination by recognition of the relationship between the prostatic apex and the symphysis pubis: When the apex is inferior to the symphysis pubis, pubectomy is not indicated. When the prostatic apex is above the lower one-third of the pubic bone, visualization is difficult from a perineal surgical incision, and a pubectomy should *be* performed ²². However, as stated above, findings at rectal examination alone can be misleading. Findings at MR imaging were found to be both accurate and objective, because in the sagittal plane the relationship between the prostatic apex and the symphysis is directly demonstrated.

Before MR imaging, only superior prostatic displacement could be evaluated clinically²²; thus, not much attention has been given to posterior or lateral prostatic displacement. Although superior prostatic displacement still plays a major role in the surgical decision, when compounded with lateral dislocation, the finding further emphasizes the need for the transpubic approach. Posterior prostatic displacement does not require pubectomy; because visualization of the prostatic apex is usually adequate. The length of the membranous urethral injury is another important factor in determining the appropriate surgical choice. If the injured segment is long, performance of pubectomy is required to allow achievement of a tension-free anastomosis between

the bulbar urethra and the distal prostatic urethra. Performance of MR imaging circumvents the problem of poor urethral filling and provides a non invasive method of measuring the distance between the prostatic apex and the corpus spongiosum, that correlates well with the surgical measurement of membranous urethral injury. The presence of extensive scar tissue, a fistulous tract, or cavities is also an important factor in favour of the transpubic approach over other approaches.

Limitations of this imaging modality include cost effectiveness. However restriction of MRI to complex PUDD especially when there is a difficulty in decision making might be truly beneficial.

Distraction injuries

Traumatic injury most frequently occurs at or near the membranous urethra, although the proximal bulbous urethra is often also involved. Straddle injuries most often affect the bulbar urethra, whereas direct blows may injure the pendulous urethra. Traumatic strictures usually develop more quickly than inflammatory strictures, and are usually solitary.

Urethral distraction injuries are the result of blunt pelvic trauma with a crushing force to the pelvis (e.g. from a high-speed automobile accident) and accompany about 10% of pelvic fracture injuries. In pelvic fracture, up to 20% of male patients with urethral injury also have associated bladder laceration. Blind urethral catheterization is contraindicated in patients suspected of having urethral injury because the catheter could be misplaced into a pelvic hematoma through a urethral injury site. When urethral injury is demonstrated, a suprapubic catheter should be placed for immediate endoscopically realignment or delayed reconstruction procedures. Although it is possible to totally disrupt the urethra with a straddle injury, these injuries most commonly involve only the bulbous urethra. However, the ensuing spongiofibrosis can be associated with complete obliteration of the urethra. Distraction injuries are for all intents unique to the membranous urethra. Pelvic fracture distraction injuries of the membranous urethra have been compared with plucking an apple (prostate) off its stem (the membranous urethra). This analogy implies that the injury most frequently occurs at the apex of the prostate. Experience shows that this is not the case, however, and the most frequent point of distraction is at the departure of the membranous urethra from the

bulbospongiosus (Andrich and Mundy, 2001; Mouraviev and Santucci, 2005). The distraction can, however, involve all or any portion of the membranous urethra between the departure of the bulbospongiosus and the apex of the prostate. In the post pubescent male, the injury seldom involves the prostatic urethra. In the prepubescent male, in whom the prostatic urethra is more fragile, the injury can extend into that area.

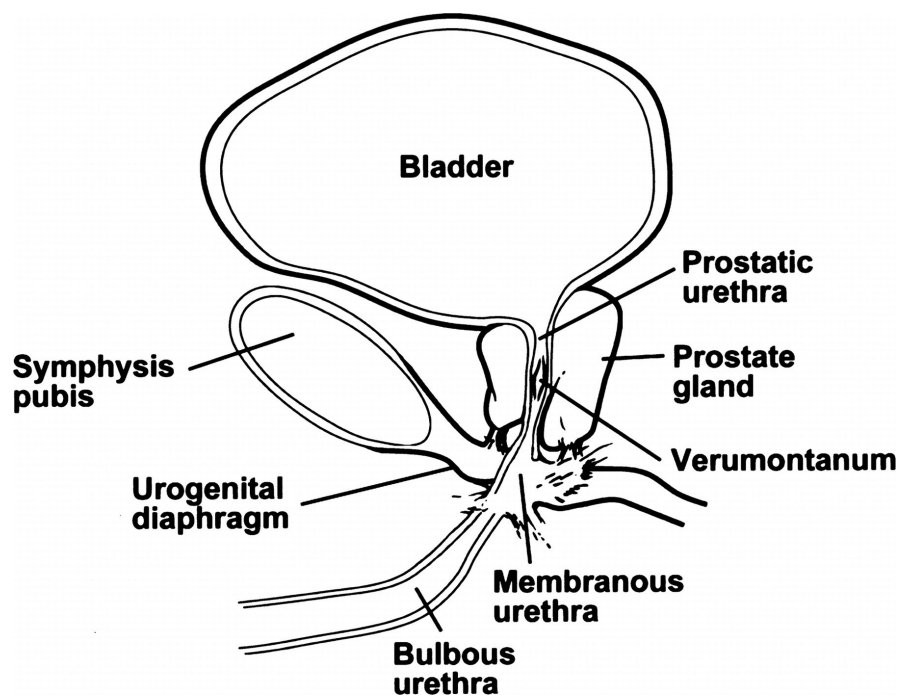


fig.2 . Showing the site of the urethra (bulbomembranous) involved in posterior urethral disruption

In 1977, Colapinto and McCallum⁸ classified posterior urethral injuries into three types on the basis of findings at retrograde urethrography. In type I injury, there is rupture of the puboprostatic ligaments. Although the prostatic urethra is stretched, the continuity of the urethra is maintained. In type II injury, the membranous urethra is torn above an intact urogenital diaphragm, which prevents contrast material extravasation

from extending into the perineum. Type II injuries have been reported to occur in 15% of cases ⁸. In type III injury, the most common form of urethral injury, the membranous urethra is ruptured but the injury extends into the proximal bulbous urethra because of laceration of the urogenital diaphragm. Type III urethral injury is characterized at urethrography by contrast material extravasation not only into the pelvic extraperitoneal space but also into the perineum. Complete disruption of the male membranous urethra, which occurs in both type II and III urethral injury, may result in dislocation of the bladder out of the pelvis, which appears as "pie in the sky" at excretory urography. Although the Colapinto and McCallum classification scheme is described as classifying posterior urethral injuries, type III injury actually extends into the bulbous portion of the anterior urethra. Type II and III injuries may be associated with incontinence related to traumatic damage to the external sphincter. Ali et al recently reported computed tomographic (CT) findings in urethral injuries. In type III urethral injury, CT demonstrates urinary contrast material extravasation at and below the urogenital diaphragm.

In 1997, Goldman et al ⁹ proposed a new unified classification system for urethral injuries following blunt trauma based on the anatomic location of the injury. The new classification system modifies and extends the Colapinto and McCallum system (type I–III injuries) into five types, with the addition of bladder base injuries (type IV and IVa injuries) and straddle anterior urethral injury (type V injury). Bladder base injuries were believed to be of particular concern because the bladder neck is the site of the internal

sphincter, which is the primary continence sphincter. Goldman et al suggested that patients with these injuries be considered for surgical therapy because there is the potential for incontinence if injury of the internal urethral sphincter is not appreciated. In addition, a second type of injury (type IVa injury), extra peritoneal bladder rupture at the base of the bladder that does not extend into the bladder neck, was included because it was believed that the extravasation from a laceration in this location would simulate a true type IV urethral injury . Because type IVa injuries do not extend into the bladder neck, there is less concern for incontinence as a result of damage to the internal sphincter; these injuries may be managed nonsurgically with bladder catheter drainage only. On the basis of the radiographic findings, extension of injury into the bladder neck and proximal urethra cannot be excluded, and type IVa urethral injuries are radiologically indistinguishable from true type IV injuries. Type V urethral injuries are caused by straddle injury and occur in the bulbous urethra. The bulbous urethra and corpus spongiosum are compressed between the hard object and the inferior aspect of the pubic bones. This compression may result in urethral contusion with an intact urethra or partial or complete rupture of the sump of the bulbous urethra. In general, a straddle urethral injury is not associated with a bone injury. If the Buck fascia remains intact, the extravasation is limited to the space between the Buck fascia and the tunica albuginea of the corpus spongiosum. If the Buck fascia is ruptured, extravasation of contrast material will be present within the confines of the Colle`s fascia at urethrography.

TREATMENT OF POSTERIOR URETHRAL DISTRACTION

DEFECT

Primary reconstruction of urethral disruption is preferred at 3–6 months, when the scar tissue at the urethral injury site is stable and mature and associated injuries have been stabilized ^{26, 27, 28}. Immediate open primary realignment of the urethral distraction is associated with a high rate of morbidity. However, selected patients suspected of having partial disruption can be treated by means of immediate "indirect," carefully performed endoscopically and fluoroscopically assisted stent placement with a urethral catheter. Late complications associated with posterior urethral injury include impotence, incontinence, stricture and fistula whereas those associated with anterior urethral injury include stricture and impotence. Urethral strictures develop in nearly all patients after a complete urethral disruption. Three to six months after initial injury, the prostate and bladder descend as the pelvic hematoma (clotted blood) is reabsorbed and organized.

Less than 10 percent of urethral strictures are complex, that is, with long urethral defects or associated with anterior urethral strictures, rectal or bladder neck injury, fistulas (abnormal passages), or chronic cavities in tissues surrounding the urethra.

Before being considered for urethral reconstruction, the patient must have:

1. No evidence of pelvic abscess or infection
2. A competent bladder neck. Since the external/membranous urethra is damaged, a

competent bladder neck is essential to assure continence after reconstruction. A static cystogram followed by voiding cystogram can assess bladder neck function.

3. No urethral instrumentation in the last three months (the scar must be stable).

DELAYED URETHROPLASTY

The time for the reconstruction of distraction defects is determined by the type and extent of associated injuries. If possible, it is desirable to proceed within 3 to 6 months after trauma. However, orthopaedic injuries of the lower extremities often necessitate a delay in proceeding with urethral reconstruction (Brandes and Borrelli, 2001).

Depending on the extent of the injury, the urethral reconstruction approach is either transperineal or combined transperineal and transpubic, the latter requiring pubectomy^{26, 27, 28}. The type of approach should be determined before surgery for several reasons. The transperineal approach is performed through a midline perineal incision, while pubectomy requires an additional incision of the lower abdomen. Therefore, if the transpubic approach is planned initially, a lithotomy position is preferable; otherwise, a deeper and more exaggerated lithotomy position is required²⁹. Other reasons include the necessity to obtain informed consent for pubectomy, to prepare appropriate surgical instruments, and to plan blood transfusion.

In the majority of cases, distraction injuries are not long, and the resultant

obliteration is amenable to a technically straightforward mobilization of the corpus spongiosum with a primary anastomotic technique. The classic reconstruction consists of a spatulated anastomosis of the proximal anterior urethra to the apical prostatic urethra. Experience has demonstrated, however, that anastomosis of the proximal anterior urethra to any segment of the posterior urethra (apical, prostatic, or below) can be successfully accomplished by a widely spatulated anastomosis in which optimal epithelial apposition is achieved. About 10% of distraction injuries are associated with more complex injuries and can be associated with fistulas (most commonly urethral rectal fistulas). Reconstruction of these injuries is technically more demanding.

Several series support the concept that the bulk of distraction injuries, even the most difficult cases, can be managed by the perineal approach (Koraitim, 1997; Flynn et al, 2003)^{29,30}. In fact, a transpubic or an abdominal-perineal approach, as pioneered by Waterhouse and colleagues (1973) , in the authors' experience is not necessary for the reconstruction of distraction injuries. In addition, pubectomy can be associated with long-term sequelae that include shortening of the penis, destabilization of erection, and destabilization of the pelvis, resulting in a chronic pain syndrome with exercise. However, there are authors who continue to rely heavily on the transpubic approach (Koraitim, 1997; Das et al, 2004).

Alternatively, the above-and-below approach does have merit when concomitant surgery is planned in the region of the bladder neck. We have found and Iselin and

Webster (1999) have reported that the competence of the bladder neck is difficult to assess accurately before the reestablishment of urethral continuity. In the past, great reliance was placed on whether the bladder neck was closed or open on cystography. We now know, however, that contrast materials can opacify the prostatic urethra when the bladder neck is more than adequately competent for continence. Similarly, confidence has been placed in the appearance of the bladder neck on endoscopic examination through the suprapubic tube. Again, even when an obvious scar is noted to involve the bladder neck, follow-up of these patients after the urethral reconstruction establishes continuity of the urethra and finds many patients with more than adequate continence. Still other patients are believed to have incontinence due to scar incarceration of the bladder neck, caused by the extensive fibrosis left behind by resolution of the hematoma. However, this is an infrequent occurrence, and the appearance of the bladder neck by any modality available is not predictive of continence. Therefore, it is necessary to reestablish the continuity of the urethra and, when there are concerns about continence, forewarn the patient before the urethral reconstruction. If these patients find that they experience less than adequate continence postoperatively, the problem is addressed in a subsequent procedure (Bhargava et al, 2004).

Materials and methods

TITLE OF THE STUDY:

Role of MR Urethrogram in the assessment of Posterior Urethral Distraction Defects

PERIOD OF STUDY:

January 2007 – March 2009.

TYPE OF STUDY :

Prospective study

SOURCE OF PATIENTS:

Patient with post traumatic posterior urethral distraction defect who presented to the Department of Urology, Madras Medical College, Government General Hospital, Chennai

PATIENT SELECTION:

Inclusion criteria:

Patients with posterior urethral disruption who were managed initially with suprapubic catheterisation and have come for definitive management (urethroplasty) were included in our study.

The institutional review board at our Hospital approved the study, and informed consent was obtained from all the patients.

All these Patients were investigated with retrograde urethrography combined with cystourethrography .Subsequently all these patients were subjected to MR Urethrography.

Exclusion criteria:

All patients who had a contraindication for MRI were excluded from the study

- 1) Patients with cardiac pacemakers,
- 2) Patients with cochlear implants,
- 3) Patients with metallic Implants / Prostheses
- 4) Claustrophobia patients.

PATIENT PREPARATION

No specific preparation.

PATIENT POSITION

Supine

IMAGING EXAMINATIONS

RGU combined with VCUG:

300 to 500 ml of iodinated contrast material (30 ml of contrast mixed with 1 L of normal saline) was instilled into the bladder through the suprapubic cystostomy catheter to the patient's tolerance. The patient was asked to void and then approximately 20 ml of diluted (50%) contrast was infused simultaneously into the urethra with a syringe and a urethral catheter. Images were obtained with the patient in the oblique position during maximum urethral distension.

MR imaging:

Before MR imaging, the patient is positioned supine over the MRI console. MR images were obtained by using a 1.5-T MR imaging device (Magnetom; Siemens, Erlangen, Germany) and a pelvic phased-array coil. Sterile lubricating jelly was injected in the anterior urethra until resistance was felt. The glans sulcus of the penis was then gently tied by using long gauze in order to avoid escape of the lubricating jelly. The penile shaft was secured in the midsagittal plane of the pelvis by using an upward traction and taping the edges of the tying gauze to the abdomen. Bladder is filled with 150-300 ml of saline through the suprapubic cystostomy catheter. High resolution sagittal T1, T2 imaging of penis and bladder was performed. Coronal, axial imaging were also obtained. The centre of the localizer was placed over the symphysis pubis to cover bladder and urethra. Patient was asked to strain and images were again obtained by opening the bladder neck. The reformatted images at different

axial, coronal, and sagittal oblique planes were obtained to delineate the entire length of the urethra, characterize the surrounding soft tissue with depth and density of periurethral fibrosis, and define the distraction defect. Processing of the images was done at a separate work station .The radiologists used the electronic calipers available at the picture archiving and communication system workstation to measure stricture length on the MR and conventional RUG images.

IMAGE ANALYSIS

RUG with VCUG images

RUG with VCUG images were analysed to estimate the site and length of urethral distraction defect (measuring the distance between the proximal end of the distal urethra and the distal end of the open proximal urethra).Displacement of the prostatic urethra and fistulous track if any were observed.

MR Urethrogram images

MR findings were evaluated with regard to the site and length of the posterior urethral distraction defect. Length was determined to be the distance between the proximal limit of the distended distal urethra and the prostatic apex on the sagittal T2-weighted image. Extent of periurethral fibrosis and presence of any fistulous tract were noted.

The degree of Prostatic apex displacement was observed.

Superior displacement : if the distance between prostatic apex & inferior pubic ramus > 1 cm;

Antero-posterior displacement: distance between prostatic apex & urethral insertion in the roof of penile bulb;

Lateral displacement: distance between prostatic apex and bulbous urethra on coronal image.

SURGICAL FINDINGS

Surgery was planned according to conventional RUG combined with VCUG findings and then if needed the planned surgical procedure was changed according to MRI findings. The length of urethral distraction defect was measured by using a centimetre ruler. The Prostatic apex displacement in the anteroposterior or superior or lateral direction was seen and the surrounding fibrotic segment was excised in all these patients who underwent anastomotic urethroplasty.

STATISTICAL ANALYSIS:

Statistical software (SPSS, version 10) was used to analyze the data. The findings from opposing urethrogram and MR Urethrogram were correlated individually with the surgical findings. The accuracy of Opposing Urethrogram and Magnetic Resonance

Urethrography were individually determined and compared. Linear regression analysis was performed to correlate the imaging and surgical measurements of distraction defect in each imaging method. The mean measurement errors of the imaging modalities were statistically analysed.

Observations and results

Total no of patients studied = 46

The patients ranged in age from 17 to 45 yr, with a mean age of 31.4 yrs.

The interval between the original trauma and the imaging varied from 3 to 9 months (mean, 4.7 months). Four cases had an unstable pelvic fracture, necessitating a pelvic fixation done at the time of the injury.

1)IMAGINGFINDINGS

In all the 46 patients evaluated with RUG combined with VCUG; the distraction defect was seen as a nonopacified segment separating the proximal and distal urethral cut ends. Out of the 46 cases, 14 cases showed non opacification of the posterior urethra as the bladder neck had not opened, resulting in spurious estimation of the urethral defect. With conventional RUG+VCUG, no information is obtained regarding the extent of fibrosis in between the urethral ends and the lateral displacement of the prostatic apex cannot be made out.

MR Urethrogram images T1-weighted images did not show a sharp distinction between the surrounding tissue and the fibrosed segment, which appears as isointense or slightly hypointense in all the patients. On the T2-weighted sagittal MR images, the gel filled urethra and saline filled bladder appeared hyperintense, with the intervening fibrosis was seen as a hypo intense area. T 2 -weighted sagittal images showed the

length of distraction, as well as the prostatic apex displacement in the anteroposterior or superior directions. Presence of any gel filled urethral fistula can also be made out. The T2- weighted coronal images showed lateral displacement of the prostatic apex in relation to the bulb of the urethra

2) LENGTH OF URETHRAL DISTRACTION DEFECT- Table 1

Length of distraction defect	Mean	SD
RUG+VCUG	3.37 cm	1.33
MR urethrogram	2.52 cm	0.95
Surgery	2.38 cm	0.94

The mean distraction defect as measured by RUG with VCUG was 3.37 (0.8-6.4) cm, by MR Urethrography was 2.52 (0.8-6) cm, and by surgery was 2.38 (0.8-5.4) cm.

t test for paired samples showed good correlation of MR detected length of distraction to surgically estimated length ($p < 0.001$)

ACCURACY OF IMAGING COMPARED TO SURGERY

For statistical analysis, up to 5 mm difference in the estimated length by either of these imaging modalities in comparison to surgery was considered accurate.

Table 2. Accuracy of RUG + VCUG compared to surgery

RUG + VCUG	Frequency	Percentage
Accurate	21 cases	45.65%
Not Accurate	25 cases	54.35%

Table 3. Accuracy of MR Urethrogram compared to surgery

MRU	Frequency	Percentage
Accurate	37 cases	80.43%
Not Accurate	9cases	19.57%

The traditional retrograde urethrography and voiding cystourethrography did not provide an accurate determination of the distraction defect, because of non opacification of the prostatic urethra in 14 out of 46 patients (30.43%). MRI provides accurate visualisation of the position of prostatic apex and the length of distraction could be accurately measured in upto 80.43% cases.

Applying Student t test, the statistical significance of the difference in accuracy of MRU and RUG + VCUG was analysed and the p value was < 0.001

The distraction defect was overestimated in 9 out of 46 (19.56%) patients at MR imaging and 25 out of 46(54.34%) patients at conventional RUG combined with VCUG imaging.

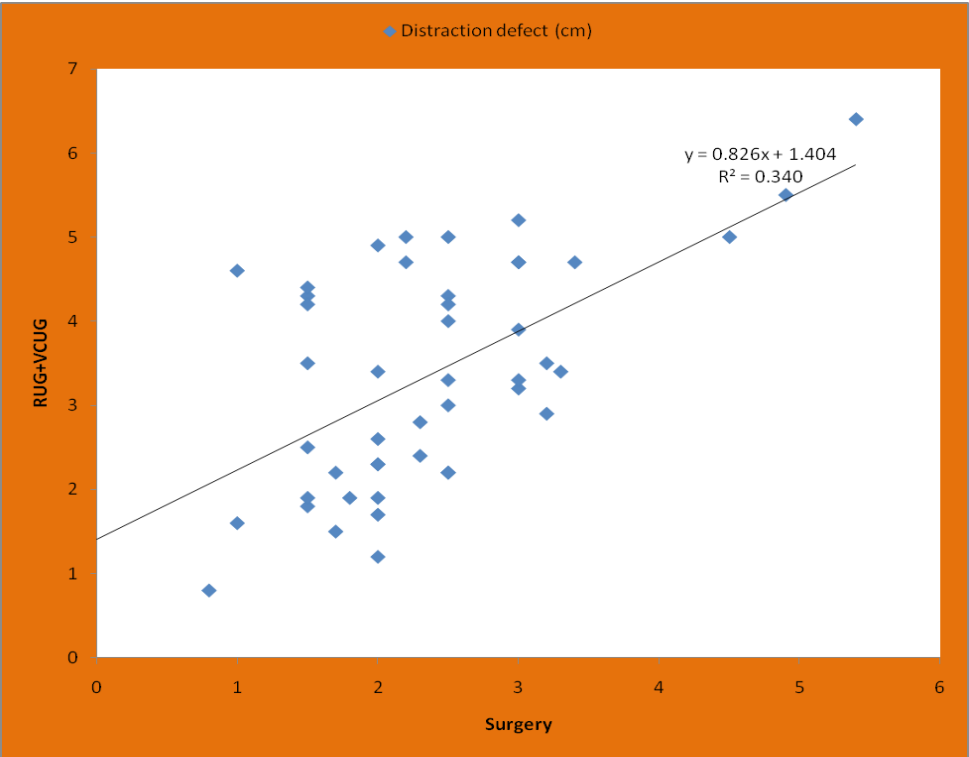
The mean measurement error at MR imaging was 0.29 cm (0–1.1 cm), and the mean measurement error at conventional RUG combined with VCUG was 1.09 cm (0–3.5 cm). (P value < 0.001)

LINEAR REGRESSION ANALYSIS

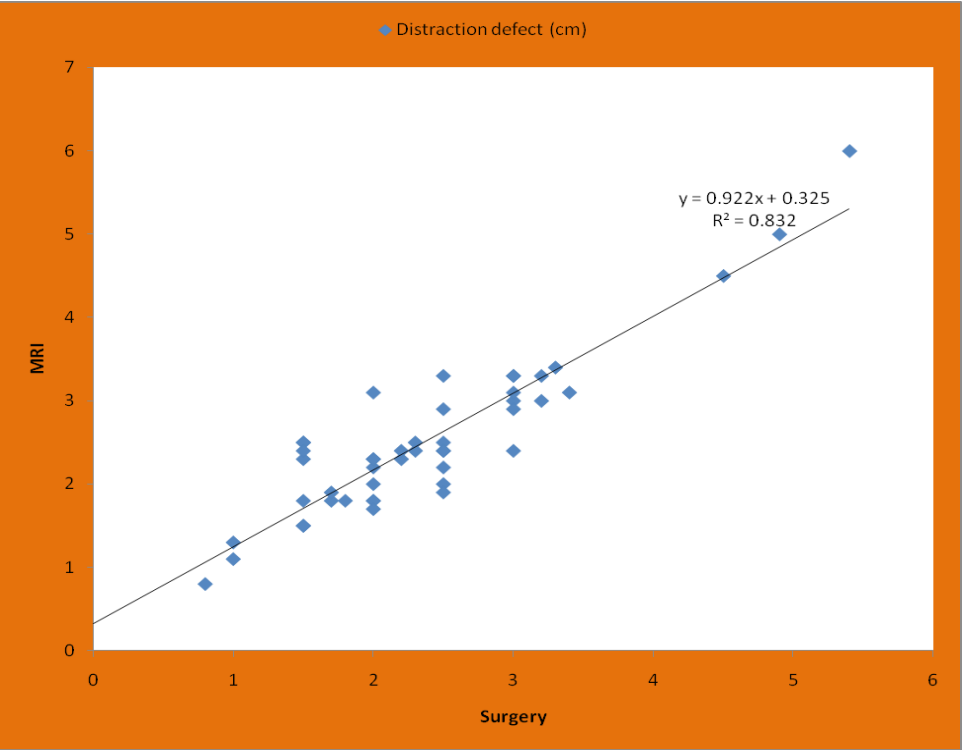
Linear regression analysis was done to find the correlation between imaging and the surgical measurements of the distraction defect.

The correlation coefficient for RUG with VCUG was $R^2 = 0.340$. The regression line was $y = 0.826x + 1.404$. The correlation coefficient for MRU was $R^2 = 0.832$. The regression line was $y = 0.922x + 0.325$. Linear regression analysis showed a stronger linear relationship between the MR and the surgical measurements ($R^2 = 0.832$, p value < .001) than that between the conventional RUG combined with VCUG and the surgical measurements ($R^2 = 0.340$, p > .05).

Linear Regression Line For RUG+VCUG



Linear Regression Line For MR Urethrogram



3) SURGICAL APPROACH

Table 4

Surgical Approach	Frequency	Percentage
Perineal urethroplasty	42 cases	91.3%
Transpubic urethroplasty	4 cases	8.7%

Table 5. SURGICAL APPROACH IN RELATION TO THE LENGTH OF DISTRACTION ESTIMATED BY RUG/VCUG

Surgical Approach	Length of distraction defect by RUG/VCUG	
	Mean (cm)	SD
Perineal urethroplasty	3.19	1.22
Transpubic urethroplasty	5.28	0.92

p <0.002

Table 6. SURGICAL APPROACH IN RELATION TO THE LENGTH OF DISTRACTION ESTIMATED BY MRU

Surgical Approach	Length of distraction defect by MRU	
	Mean	SD
Perineal urethroplasty	2.33	0.65
Transpubic urethroplasty	4.47	1.5

p<0.001

In our study 4/46 cases required transpubic urethroplasty. The mean distraction defect estimated by RUG+VCUG and MRUrethrogram was 5.28 cm and 4.47 cm respectively. On the other hand the remaining cases which required perineal urethroplasty the mean distraction defect estimated by RUG + VCUG and MRUrethrogram was 3.19cm and 2.33cm respectively. Applying the t test for equality of means, statistical significance was seen between the length of distraction estimated by both these imaging and the type of surgical approach.

With conventional imaging posterior urethra was not clearly delineated in 14 (30.4%) cases and the imaging showed a spurious estimation of the distraction defect. If the distraction defect is long, performance of a pubectomy is required to achieve a tension-free anastomosis between the bulbar urethra and the distal prostatic urethra. Performance of MR imaging circumvents the problem of poor urethral filling and provides a noninvasive method of measuring the distance between the prostatic apex and

the corpus spongiosum that, in our study, correlated well with the surgical measurement of membranous urethral injury.

4) Table 7. DISPLACEMENT OF PROSTATIC APEX

Investigation	Displacement of prostate apex	Percentage
RUG + VCUG	14 cases	30.43%
MRU	42 cases	91.3%
Surgery	39 cases	84.78%

Table 8. Displacement of apex detected in RUG + VCUG compared to surgery

	Surgery displacement +	Surgery displacement -	Total
RUG + VCUG Displacement +	14	-	14
RUG + VCUG Displacement -	25	7	32

Total	39	7	46
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p >0.05

Statistical analysis (Chi Square test) showed poor correlation between RUG+VCUG and surgery in detecting prostatic apex displacement (p >0.05)

Table 9. Displacement of prostate apex detected in MRU compared to surgery

	Surgery displacement+	Surgery displacement -	Total
MRU Displacement +	39	3	42
MRU Displacement -	-	4	4
Total	39	7	46

p<0.001

Chi Square test showed good correlation between MRI and surgery in detecting displacement (p < 0.001)

RUG + VCUG provides little information on the extent of prostatic apex displacement.

MR imaging clearly shows the degree and direction of the prostatic displacement, which aids in preoperative decision making.

5) SUPERIOR DISPLACEMENT OF PROSTATIC APEX

Superior displacement of the prostatic apex was seen in 24 cases (range 1-3cm, mean 1.5 cm), Lateral displacement in 11 cases (range 0.5-0.8cm , mean 0.6 cm) ,anteroposterior displacement in 10 cases(range 0.5-1cm , mean 0.7 cm), and displacement in more than one direction in 5 cases.

Table 10. SUPERIOR DISPLACEMENT OF PROSTATIC APEX IN ALL THE MODALITIES

Investigation	SUPERIOR DISPLACEMENT OF PROSTATE APEX		
	< 1 cm	1-2 cm	> 2 cm
RUG + VCUG	3	4	-
MRU	8	12	4
Surgery	5	12	4

ANALYSIS OF THE RELATIONSHIP OF THE DEGREE OF SUPERIOR DISPLACEMENT OF PROSTATE APEX TO THE SURGICAL APPROACH BY

BOTH THE IMAGING MODALITIES

Table 11. RUG+VCUG

RUG+VCUG	Perineal urethroplasty	Transpubic urethroplasty	
No superior displacement	24	-	24
< 1cm displacement	3	-	3
1 - 2 cm displacement	3	1	4
Non opacified posterior urethra	11	3	14
Total	42	4	46

$p > 0.2$

Table 12. MRU

MRU	Perineal urethroplasty	Transpubic urethroplasty	
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No superior displacement	22	-	22
< 1cm displacement	8	-	8
1 - 2 cm displacement	12	-	12
> 2 cm displacement	-	4	4
Total	42	4	46

p <0.001

Out of the 21 cases which showed superior displacement of prostatic apex during surgery, 4 cases needed a combined abdominoperineal approach (transpubic urethroplasty).RUG+VCUG detected only 7 cases of superior displacement of prostate apex,out of which one case needed transpubic urethroplasty.The displacement of the apex seen in that case was 1.8 cm from inferior border of pubic symphysis.Out of the 14 cases which showed poor visualisation of the posterior urethra, due to failure of bladder neck opening during the voiding study,3 cases needed transpubic urethroplasty. MRI showed superior displacement of prostate apex in 24 cases, out of which 4 cases showed severe displacement of > 2cm from lower border of pubic symphysis.The remaining cases which showed displacement < 2cm were managed with perineal urethroplasty.

This correlation was found to be statistically significant.($p < 0.001$).

MRI was found to be more sensitive in detecting displacement of prostate apex and the degree of displacement had good correlation with the surgical findings. In the conventional imaging failure of opacification of posterior urethra was seen in 14(30.4%) cases, out of which 3(21.4%) cases had > 2 cm displacement of prostate apex, which could be identified preoperatively by MRI rather than RUG+VCUG. So this information obtained by MRI is very useful in planning the approach beforehand.

6) FISTULA IMAGING

Table 13. RUG + VCUG vs SURGERY

RUG+ VCUG	SURGERY		
	Fistula +	Fistula -	
Fistula +	3	-	3
Fistula -	3	40	43
Total	6	40	46

$p < 0.002$

In our study we had 6/46 cases of PUDD with fistula from the urethra. Fistulous

tract was detected in only 3 cases with RUG+VCUG. Out of the six cases, we had 2 cases presenting with rectourethral fistula. RUG+ VCUG showed the rectourethral fistula as a small contrast filled tract going from the prostatic urethra posteriorly in one case alone, the other one fistula could not be demonstrated.

Table 14. MRU vs SURGERY

MRU	SURGERY		
	Fistula +	Fistula -	
Fistula +	6	-	6
Fistula -	-	40	40
Total	6	40	46

$p < 0.001$

In MR Urethrogram fistula was clearly demonstrated in all the cases, and in those 2 cases of rectourethral fistula MRI clearly delineated the fistulous communication between prostatic urethra and rectum along with superior displacement of apex. Both these cases were managed by diverting colostomy and urethroplasty was done subsequently by transpubic approach.

MRI has double the sensitivity of RUG + VCUG in the detection of fistula.

Discussion

Conventional retrograde urethrogram combined with voiding cystourethrogram, is the method traditionally used for planning a urethral reconstruction. This technique, however, often cannot provide an accurate determination of the defect because of the poor prostatic urethral filling, and it provides little information on the extent of fibrosis of the corpora spongiosa or the prostatic displacement. Defect length may be grossly overestimated if the bladder neck does not relax. Both the proximal and distal extents of the defect can be demonstrated if the patient can open the bladder neck. It is rarely possible, however, to demonstrate the proximal limit of the defect because patients often have a diminished bladder capacity after months of suprapubic diversion and are unable to tolerate bladder distension sufficient to open the bladder neck voluntarily. A failure to demonstrate the prostatic urethra does not necessarily indicate a bladder neck obstruction or a stricture all the way up to the bladder neck. To help identify the proximal limit of the distraction defect, various other methods like Bougieogram (introducing a curved metal sound through the suprapubic cystostomy track into the bladder and down through the bladder neck), combined endoscopic assessment of bladder neck and prostatic urethra with simultaneous filling of penile urethra retrograde were all described.

MR imaging is likely the best imaging modality for assessing the post traumatic pelvic anatomy and provides a noninvasive method for measuring the defect length with none of the problems associated with the conventional radiographic technique. In addition, MR imaging clearly shows the extent of the scar tissue, as well as the degree

and direction of the prostatic displacement, which aids in preoperative decision making.

In our study all the cases of posterior urethral distraction defect were following pelvic trauma with pelvic fracture, with 4 cases of unstable pelvic fracture necessitating intervention in the form of pelvic fixation done at the time of trauma.

The mean distraction defect estimated by MRI showed good correlation with the surgically estimated defect. Mean defect length was 2.52(0.8-6) cm with MRI and 2.38 (0.8-5.4) cm with surgery. The exact determination of the defect was not possible with the conventional imaging as there was non visualisation of posterior urethra in 14(30.43%) cases. The mean measurement error was low with MRI compared to RUG/VCUG. Further linear regression analyses showed good correlation between MRI and surgery with correlation coefficient of $R^2=0.832$

In most of the cases displacement of prostate apex was not made out in the usual imaging, but MRI was very sensitive in identifying the type and degree of displacement in these patients. MRI also helped in identifying presence of complex fistulous tract. We had 2 cases of rectourethral fistula presenting 3 and 7 months after trauma. MRI clearly showed the fistula communicating prostatic urethra with the rectum. Both these patients were managed with diverting colostomy and definitive urethral repair later.

Most importantly MRI is very useful in planning the surgical approach. With the use of RUG/VCUG for assessment of the distraction defect correct measurement of the

defect could be obtained in only 32 /46 cases. The remaining cases posterior urethra was not well delineated. MRI shows the position of the prostatic apex and so despite nonfilling of the prostatic urethra correct measurement of the defect can be made. We saw that in 4 cases out of 46 MRI showed a superior displacement of prostatic apex more than 2 cm from the inferior border of the pubic ramus. Two of these four cases also had a rectourethral fistula detected by MR imaging. All these 4 patients needed transpubic anastomosis of the prostatic apex to the distal urethra, as the prostatic apex was found to be superiorly displaced and was inaccessible through the perineal route. The degree of the prostatic displacement seen peroperatively correlated with the MR findings. This suggests that if MRI shows a superior displacement of the prostatic apex more than 2 cm from the lower border of the pubic symphysis, transpubic approach is needed.

The future of MR Urethrogram in the evaluation of posterior urethral distraction defects is mainly in cases with complex urethral distraction injuries, patients with multiple fistulae and in children.

Conclusion

- Magnetic resonance imaging of the urethra is an interesting diagnostic tool and should become part of the urologists diagnostic armamentarium.
- MR urethrography is a promising tool for defining post traumatic posterior urethral distraction defects as an alternative to traditional radiographic methods.
- MR urethrography could accurately measure the distraction defect length, judge the extent of fibrosis, and aid in the diagnosis of any associated pathologies.
- It has significantly greater accuracy ,with low mean error in the measurement of distraction defect compared to the conventional opposing urethrogram.
- MR urethrography can provide extra guidance for treatment planning that cannot be obtained with RUG.

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PATIENT CONSENT FORM

Study Title : **Role Of MR Urethrogram in the assessment of Posterior Urethral Distraction Defects**

Study Centre : **Department of Urology**

Patient's Name :

Patient's Age :

Identification No :

Patients may tick these Boxes []

I confirm that I have understood the purpose of procedure for the above study. []

I have the opportunity to ask the questions and all my questions and doubts have been answered to my complete satisfaction. []

I understand that my participation in the study is voluntary and that I am free to withdraw at any time without giving any reason, without my legal right being affected []

I understand that sponsor of the clinical study, others working on the sponsor's behalf, the ethics committee and the regulatory authorities will not need my permission to look at my health records both in respect of the current study and any further research that may be conducted in relation to it, even if I withdraw from study. []

I agree to this access, however, I understand that my identity would not be revealed. In any information released to third parties or published, unless as required under the law. []

I agree not to restrict the use of any data or results that arise from this study. []

I agree to take part in the above study and to comply with the instructions given during the study and to faithfully to cooperate with the study team, and to immediately inform the study staff if I suffer from any deterioration in my health or my well being or any unexpected or unusual symptoms. []

I hereby give consent to participate in this study. []

Signature / Thumb Impression
of the patient:

Place :

Patient's name and address :

Signature of the Investigator :.....PlaceDate

Name of the Investigator :

PROFORMA

The following proforma was used to collect statistical data for analysis from all the patients.

Name:

Age:

Sex:

I.P.No:

CLINICAL DETAILS:

Date of pelvic trauma causing pelvic fracture with urethral disruption

Details of management at the time of trauma

Insertion of SPC

Type of pelvic fracture and whether fixation was done for pelvic fracture

Duration between primary injury and presentation to the hospital for

definitive repair

SYMPTOMS:

Inability to void via naturalis

H/O impotence since injury

H/O any walking or squatting difficulty due to the pelvic fracture

EXAMINATION:

General examination

Per abdomen examination

Per rectal examination

Neurological examination: gait of the patient /reflexes

INVESTIGATIONS:

X ray pelvis AP/Lat

RUG/VCUG

MRUrethrogram

**Posterior Urethral Distraction Defect characteristics in both the imaging modalities
compared with surgical findings**

	RUG/ VCUG	MRU	SURGERY
Anterior urethra			
Posterior urethra			
Length of distraction defect (in cms)			
Prostatic apex			
Displacement(in cms)			
Fibrosis			
fistula			

GLOSSARY

RTA	-	Road traffic accident
#	-	fracture
RUG	-	Retrograde urethrogram
VCUG	-	Voiding cystourethrogram
MRU	-	MR urethrogram
SD	-	Superior displacement of prostate apex
N	-	No
Y	-	Yes
A	-	<1 cm superior displacement of prostate apex
B	-	1-2 cm displacement
C	-	> 2cm displacement
PU	-	Perineal urethroplasty
TU	-	Transpubic urethroplasty

